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The Short-Run Impact of Interest Rates on Exchange Rates: Results for the Swiss franc Against the Euro and US Dollar from Daily Data 2001 – 2011

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Abstract: This paper provides an econometric analysis of the short-run impact of interest rates on the Swiss franc exchange rate covering the period January 2001 to June 2011 using daily data. Our model includes both the exchange rate of the Swiss franc against euro and dollar and uses the plausible assumption that foreign interest rates and the euro-dollar exchange rate are exogenous. In addition, we consider not only money market interest differentials, but also those for 2 and 10 year governments bonds. GMM estimation indicates that a one-percentage point increase in the 3-month Swiss franc Libor rate leads to a 3.7 % appreciation of the Swiss franc against euro and dollar. This result seems to be robust with respect to considering only increasing or decreasing interest rates and omitting data around SNB target band adjustments. Our findings appear reasonable and are between the extremely low and high estimates of the impact of Swiss interest rate changes on the exchange rate reported in the literature.

JEL classification
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Interest rates, money and bond market, exchange rates, GMM-estimation

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1. Introduction

The empirical evidence on the short-run impact of interest rates on the exchange rate of the Swiss franc is rather mixed: in their event study Ranaldo and Rossi (2010) find a 0.17% appreciation of the Swiss franc against the US dollar in reaction to 25 bp increase in the 3-month CHF Libor rate for the period 2000-2005. However, there is the more recent event study of Ferrari et al. (2017) for the period 2010 to 2015 suggesting a 6.25% appreciation in response to a 25bp increase in the 1-month Swiss franc OIS rate. Canetg and Kaufmann (2019) report a similarly strong effect obtained by a VAR analysis of the impact of the SNB bills auctions of the years 2008 to 2011 on the money market rate and the exchange. The SVAR model estimated with weekly data from 2000 to 2011 by Grisse (2019) provides the result that a 25bp contractionary shock in the 3-month CHF Libor rate leads to a contemporaneous 0.5% appreciation of the Swiss franc, which increases to approximately 1% within 12 weeks. Similarly, Fink et al. (2019) find an appreciation of 0.5% in reaction to a 25 bp increase in the 3-month Libor rate for the period 2000-2011.The difference between some of these estimates is striking, even if we account for different samples and methods as well as the sampling errors of these estimates.[1]

This paper provides an econometric analysis of the short-run impact of interest rates on the Swiss franc exchange rate, covering the period January 2001 to June 2011 with daily data. This period contains 21 changes of the target 3-month Swiss franc Libor rate of the SNB in both directions and therefore provides quite substantial interest rate variability. Moreover, by contrast to the period from September 2011 onwards with dominant foreign exchange market interventions, the money market interest rate was SNB's major policy instrument during the 11 years considered.

Our model includes both the exchange rate of the Swiss franc against the euro and the US dollar and uses the plausible assumption that changes in Swiss interest rates have no influence on the exchange rate between euro and dollar. In addition, we consider not only money market differentials, but also those for 2 and 10 year government bond yields and we take into account a couple of exogenous determinants of the exchange rates. The model is estimated by

[1] The empirical international literature on the effects of interest rates on exchange rates reports highly significant and immediate effects. The impact estimates range typically from 1.2% up to 6% nominal appreciation in response to a contractionary 1 percentage point interest rate shock, see, e.g., Ferrari et al. (2017), Kerssenfischer (2019), Rosa (2011) and Kearns and Manners (2006).

GMM assuming that there is a simultaneous relation between the Swiss interest rates and the exchange rates and that the foreign interest rates are exogenous. The simultaneity problem arises by the policy reaction to exchange rates changes, which is a characteristic of monetary policy in the highly open Swiss economy. The paper by Fink et al (2019) uses the same sample period but a different identification strategy: the effect of interest rates on exchange rates is identified by exploiting the heteroscedasticity between days with and without monetary policy announcements.

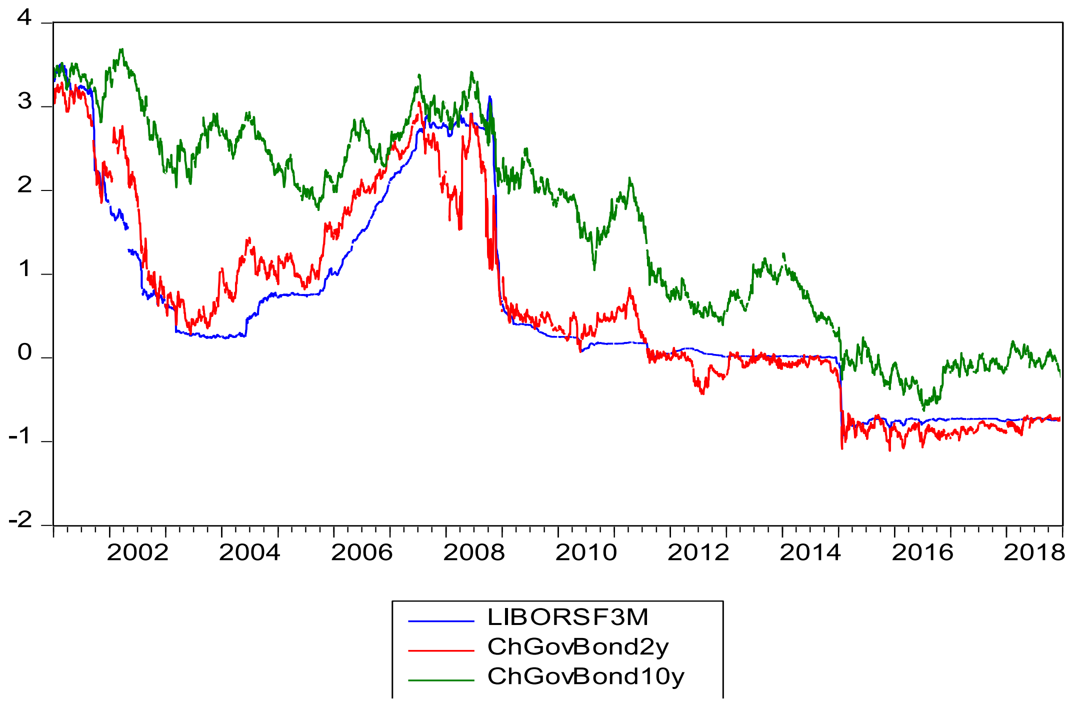
The paper is organized as follows. Section 2 provides an analysis of the relationship between the 3-month Swiss franc Libor rate and the two Swiss government bond returns. Section 3 displays the exchange rate model estimates and section 4 concludes.

2. Swiss franc Libor and government bond returns

In order to analyze the relationship between the three involved Swiss interest rates we start with a look at the data. Figure 1 displays the daily time series for the three interest rates over the years 2001-2018. The extension of the sample for the analysis of the Swiss interest rates beyond the period used in estimation of the exchange rate model allows us to highlight the change in interest rate patterns after 2011. Moreover, the longer period allows a more meaningful cointegration analysis. We see a fall of the Libor rate from 2001 to 2004 under monetary easing of approximately 3 percentage points, which is followed by a period of monetary tightening with rising interest rates up to fall 2008. The financial and euro-government-finance crisis has triggered a very expansionary monetary policy since then. The zero lower bound is essentially reached in August 2011 and in January 2015, we have the move of SNB to a negative interest rate operating target.

The graph suggests that there is a long run level relationship between the two years government bond return (ChGovBond2y) and the Libor rate (LIBORSF3M). By contrast, this seems not be the case for the ten years government bond (ChGovBond10y). Moreover, both bond returns are considerably more variable then the Libor rate.

Figure 1: CH government bond returns and 3M Libor, January 2001 – December 2018



As the series appear non-stationary, we use cointegration methods to test and estimate a possible level relationship between the series. Table 1 reports the separate Fully Modified OLS regression estimates as well as the Phillips-Ouliaris test of the null hypothesis of no cointegration for the bond rates with the Libor rate. The results presented confirm our conjectures from Figure 1: there is a strong relationship between the 2y bond rate and the Libor ($R^2 = 0.91$) and we clearly reject the hypothesis of no cointegration. The slope coefficient of 0.98 is not statistically different from 1 indicating that 2y bond return and Libor rate move pari passu in the long run. The intercept of 0.08 reflects the slightly higher level of the bond rate. Note that the AR(1) coefficient estimate of the residuals is high, namely 0.989, even if it is statistically significantly lower than 1. This means that on average deviations from the cointegrating relationship are corrected at a rate of approximately 1.1%, which is rather high for daily data. It implies a half-life of a deviation from long-run equilibrium of approximately 70 days. Nevertheless, daily variation of the two interest rates is sufficiently different in order to include them separately in the exchange rate equations.

By contrast, the hypothesis of no cointegration cannot be rejected at all reasonable significance levels for the 10y bond and the co-movement of this series with the Libor rate is much weaker. Indeed, the level regression appears "spurious" and the statistics with respect to these estimates cannot be trusted. Nevertheless, there appears to exist a relationship between the changes in the 10y rate and 3M-Libor: the corresponding regression results in a statistically significant slope coefficient estimate of 0.20 (se = 0.060).

Finally, we should mention that these results are robust with respect to the sample period 2001 to 2018. If it is reduced to 2001 to 2011 the results are qualitatively equal and quantitatively only slightly different, even if they are less statistically significant.

Table 1: Cointegration estimates and test CH government bond returns and 3M Libor (X_t), January 2001 – December 2018

$Y_t = a + bX_t + e_t$; $e_t = \rho e_{t-1} + u_t$

Y_t	a	b	R^2	ρ-1, bias corrected	Phillips Ouliaris t
2y	0.0801*** (0.0177)	0.9819*** (0.0138)	0.9133	-0.0107*** (0.00269)	-4.681***
10y	1.0921*** (0.0335)	0.8938*** (0.0302)	0.7166	0.00181 (0.00181)	-2.065

Standard errors in parentheses, *, ** and *** denotes significance at the 10, 5 and 1% level, respectively.

3. The model for the exchange rates

In this section, we estimate a model for the rate of change of the Swiss franc exchange rate against the euro and dollar with the interest differentials for the Libor rates and the government bond returns as the key explanatory variables. Because of SNB's policy response to exchange rate movements, we consider Swiss interest rates as endogenous. By contrast, foreign interest rates are assumed to be exogenous, as Swiss monetary policy has plausibly no influence on Euro area and US monetary policy. Besides, we add some other exogenous variables. These controls turned out as important determinants of the Swiss franc exchanges rates in the empirical analysis of Fink, Frei and Gloede (2019).

Firstly, let us briefly define the variables involved in our empirical analysis. Table 1 presents the variables and the respective transformations. The data source is Bloomberg L.P. and we sample the variables at the end of the trading day. The endogeneous variables are the Swiss exchange rates EURCHF and USDCHF, the 3-month CHF Libor as well as Swiss government bond yields. Furthermore, as control variables we follow the selection of financial drivers similar to Fink, Frei and Gloede (2019): for capturing currency-specific dynamics we use the euro and US dollar factor, which is the mean of the rate of change of the euro or dollar against 26 currencies (excluding the Swiss franc). To capture the risk environment, we include several risk variables: the EU-periphery to Germany government bond spread (10Y), the VIX risk appetite index and the Gold spot price.

Table 1: Overview financial variables

Name	Description	Transformation	Unit
	Endogenous Variables		
DLEUR	EURCHF exchange rate	Log return	Percent
DLUSD	USDCHF exchange rate	Log return	Percent
LIBORSF3M:	3-month CHF Libor	-	Percent
ChGovBond2y	Swiss government bond yield (2Y)	-	Percent
ChGovBond10y	Swiss government bond yield (10Y)	-	Percent
	Exogenous Variables		
DEURF	Euro factor: Mean across 26 daily FX log returns	Log return	Percent
DLUSD	US dollar factor: Mean across 26 daily FX log returns	Log return	Percent

DIDPER	Interest rate differential EU periphery vs. Germany (10Y)	First difference	Percentage points
DVIX	US volatility index	First difference	Percentage points
DLPG	Gold price	Log return	Percent
LIBOREU3M	3-month Euro Libor	-	Percent
LIBORUS3M	3-month US Libor	-	Percent
DEGovBond2y	German government bond yield (2Y)	-	Percent
DEGovBond10y	German government bond yield (10Y)	-	Percent
USGovBond2y	US government bond yield (2Y)	-	Percent
USGovBond10y	US government bond yield (2Y)	-	Percent

Figure 2 plots the two exchange rate series. Against the euro, we note a slight depreciation of the franc until the end of 2007. Thereafter, we note a sharp appreciation of the Swiss franc, which led then to the introduction of the 1.20 floor against the euro in September 2011, which in turn created a quasi-fixed exchange rate for the euro until the abolishment of the floor in January 2015. Since then we note a slight appreciation tendency of the euro. The franc-dollar exchange rate displays a trend appreciation until fall 2011, which turns then into a slight depreciation tendency.

Figure 2: Swiss franc exchange rates, euro and USD, January 2001 – December 2018

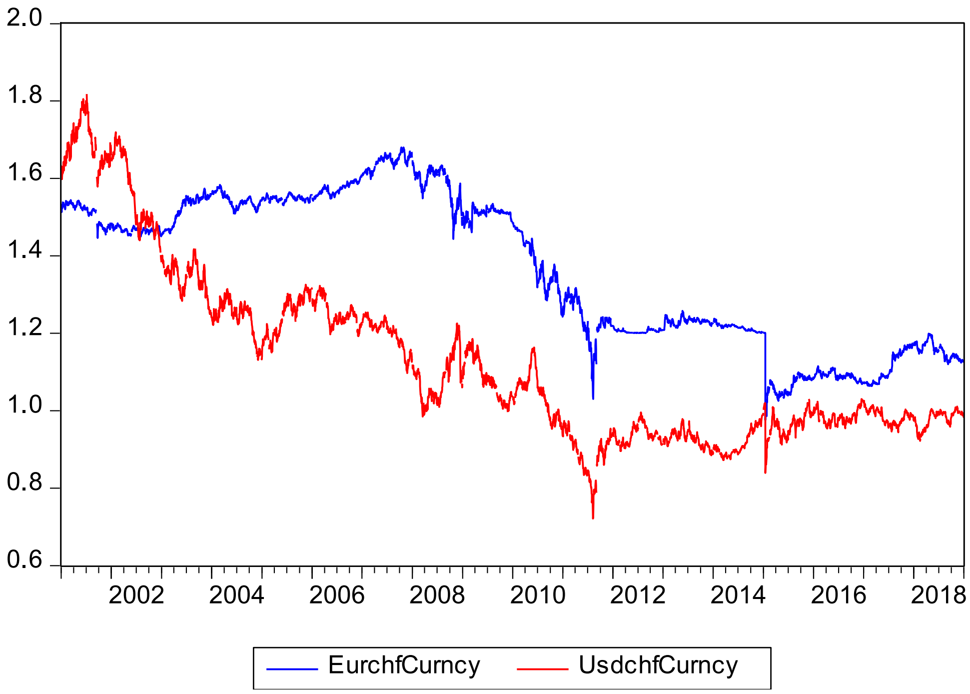


Figure 3 provides the plots of the Libor and government bond interest rate differentials for the Swiss franc against the euro and the US Dollar. For both currency pairs we see rather volatile differentials which a mean between 1.5 and 2 % before the financial crisis. Since then we note a more or less continuous shrinking of the differentials against the euro, whereas this trend is reversed for the dollar around 2012.

Figure 4 shows the development of SNB's target band for the 3-month CHF Libor. We see that we had over twenty changes in the target band up to June 2011 and this makes this period interesting for estimating the impact of interest rate changes on the exchange rate. By contrast, we see only three adjustments of the target band since then. This illustrates that the interest rate was the major policy instrument until the introduction of the exchange rate floor.

Figure 3: Interest rate differentials Euro-Franc and Dollar-Franc

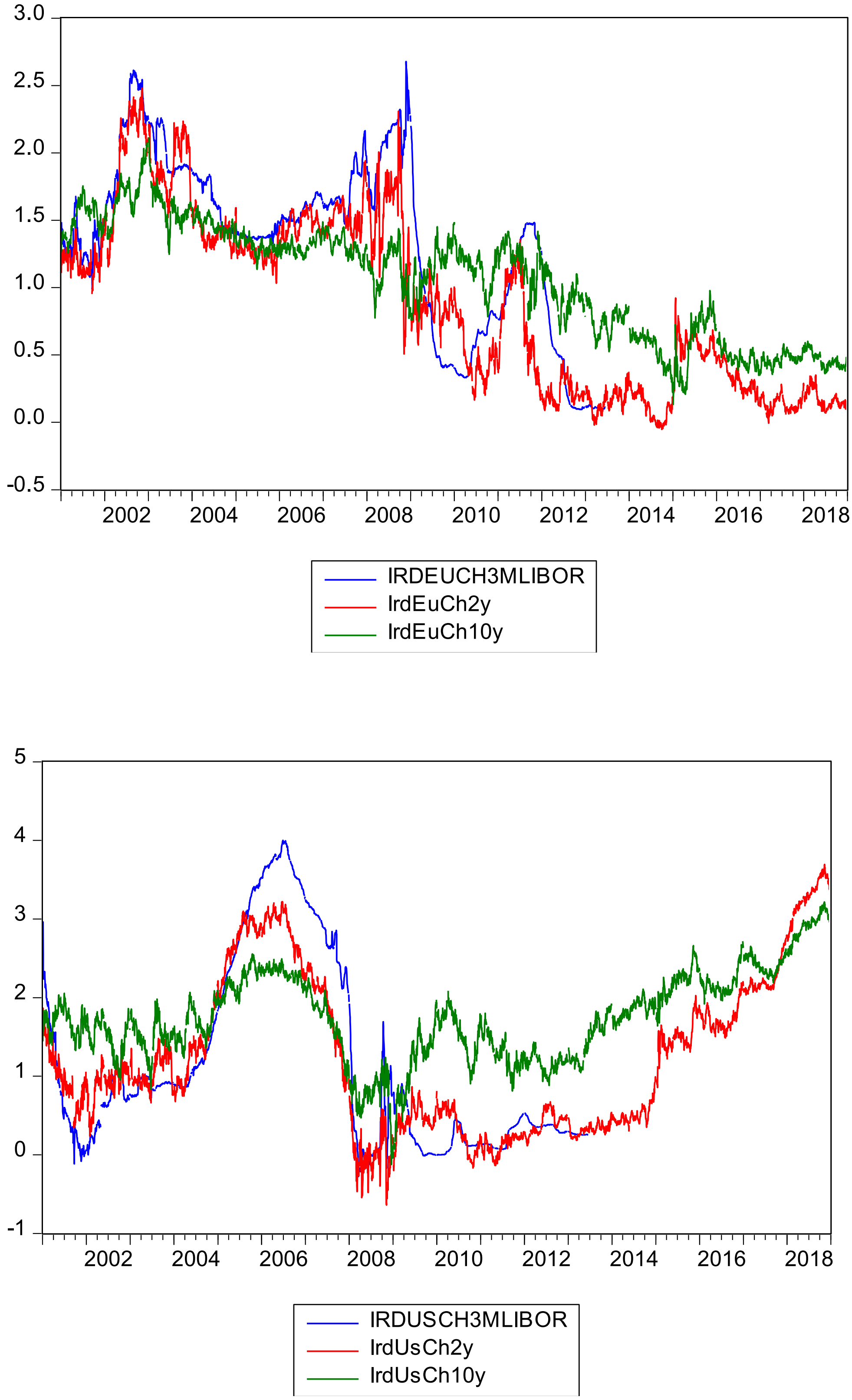
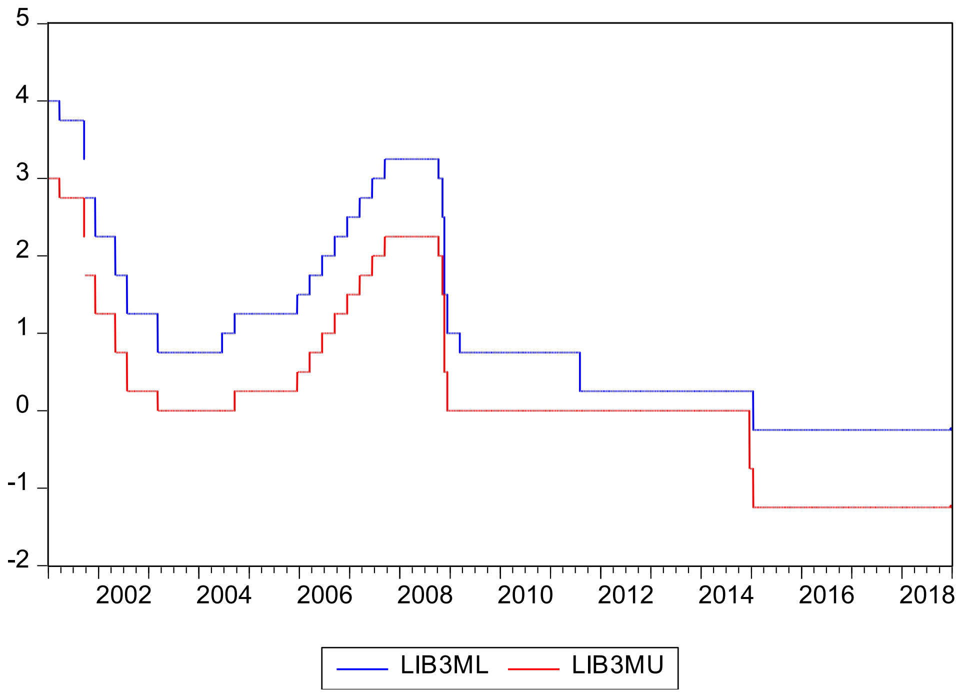


Figure 4: SNB's target band for 3-months CHF Libor 2001 - 2018



Our model relates the rate of change in the two exchange rates (100 times difference of log) to the three interest rate differentials as well as the listed exogenous variables. We allow for a simultaneous relation between the changes in exchange rates and changes in the Swiss interest rates. This implies that the interest rate differentials become endogenous. However, we use the plausible assumption that changes in foreign interest rates are exogenous. Besides these two equations, we complement the system by two equations relating the changes of the Swiss government bond rates to the changes in the Libor.

We use the Generalized Methods of Moments taking into account heteroscedasticity using the White covariance matrix in the moment conditions. The equations are estimated jointly and we have three cross equations restrictions: the regression coefficients of the interest rate differentials should be the same in the euro and in the dollar equation. A violation of this restriction implies that changes in Swiss interest rates have an influence on the exchange rate between euro and dollar, which appears implausible.

We use one lag of all endogenous variables and all exogenous variables as instruments. The equations are over-identified and we can test the model's appropriateness by a large number the over-identifying restrictions, namely 55.

Table 2 shows the estimation results obtained for the sample January 2001 to June 2011. The Table displays the restricted estimates with the same interest rate differential coefficient in both exchange rate equations. The unrestricted estimates of the system support these restrictions: the test statistic with a chi-squared distribution with 3 degrees of freedom is 5.47, which is not significant at any usual significance level (marginal significance = 0.14). Moreover, the over-identifying restrictions cannot be rejected at all reasonable significance level.

The interest rate differential coefficients of euro area/Germany and the US against Switzerland have the right positive sign: an increase of a Swiss interest rate leads immediately to a appreciation of the Swiss franc. In particular, the bond rate differentials are significant at the 1 percent level. We find impact coefficient estimates between approximately 1.5 and 1.8. In addition, we find a highly significant relation between the changes in the bond rates and the Libor rate. The corresponding coefficients are 0.68 and 0.61 for the 2 and 10 years bond differential, respectively. All statistically significant effect of the exogenous determinants have the expected sign. In particular, we see that the last three "crisis" indicators have a strong negative effect on the Swiss exchange rates. This reflects the tendency of the Swiss franc to appreciate in times of crises. We note highly significant effects of the Euro and dollar factor, which are in particular important in the dollar equation.

Table 2: GMM estimation four variables model, daily data, January 2001 to June 2011

Endogenous variables	DLEUR	DLUSD	DChGovBond 2y	DChGovBon d10y
Right-hand side variables				
DIRDEUCHLIBOR	1.517* (0.866)		0.671*** (0.132)	0.619*** (0.097)
DIRDDECH2Y	1.619*** (0.415)			
DIRDDECH10Y	1.769*** (0.619)			
DIRDUSCHLIBOR		1.517* (0.866)		
DIRDUSCH2Y		1.619*** (0.415)		
DIRDUSCH10Y		1.769*** (0.619)		
DIRDUSDELIBOR	-1.082 (0.739)	-1.152 (0.733)		
DIRDUSDE2Y	0.190 (0.237)	-1.112 ***(0.359)		
DIRDUSD10Y	0.367 (0.257)	-1.629 ***(0.552)		
DEURF	0.091*** (0.031)	-0.956*** (0.0320)		
DUSDF	-0.138*** (0.0229)	0.848*** (0.023)		
DIRDPER	-0.575*** (0.179)	-0.483*** (0.176))		
DLPG	-0.046*** (0.0072)	-0.046*** (0.0075)		
DVIX	-0.0554*** (0.0062)	-0.061 ***(0.0062)		
se (std error residual)	0.330	0.340	0.045	0.036
DW	2.052	2.059	2.023	1.861
J (p-value)	0.2167			

Standard errors in parentheses, *, ** and *** denotes significance at the 10, 5 and 1% level, respectively. J is the test statistic for over-identifying restrictions

What are the implications for the total effect of changes in the Libor on the exchange rate? This can be easily calculated by adding the direct effect and the product of the Libor impact on the two bond rates with the exchange rate effect of the bond differentials. Table 3 displays this calculation. Besides the point estimate of the total effect of a 1 percentage point increase in the Libor, which is 3.69%, we calculate the standard error of this estimate using the covariance matrix of the system estimates. The 95% confidence interval is accordingly [1.66%, 5.73%]. Our point estimate is larger than that obtained by Fink et al. (2019) by the identification by heteroscedasticity approach, which turned out to be around 2.0% for both exchange rates. However, these values are within the 95% confidence interval of our estimate and we should underline that both estimates point to a highly statistically significant effect of interest rates on the Swiss franc exchange rate.

Table 3: Effect of Libor 1% percentage point increase on exchange rate (percent)

Direct exchange rate effect	Effect on gov bonds return	Effect of gov bond return on exchange rates	Total effect
1.517	0.671 (2y) 0.619 (10y)	1.080 1.095	3.692*** (1.039)

Standard error in parentheses, *, ** and *** denotes significance at the 10, 5 and 1% level, respectively.

Table 4 reports some robustness checks for the estimate of the interest rate effect reported in Table 3. First, we estimate the restricted model for increasing and decreasing interest rates separately. Second, we omitted the dates of changes in the Libor target band as well as the four preceding and following days.

According to Table 4 our estimate of the impacts of changes in the 3-month CHF Libor on exchange rates seem to be very robust. We detect essentially no effect on the estimates of omitting 9 days around changes in the target band. The impact on the exchange rate of rising interest rates seems to be larger (4.53%) than that of sinking interest rates (2.61%). However, the difference is clearly not statistically significant given the standard errors of the estimates.

Table 4: Different samples for estimating the impact of change in Libor on exchange rate, daily data, January 2001-August 2011, restricted estimates (percent)

Specification	Estimated impact	Standard error
Full sample	3.692***	1.039
Increasing interest rate	4.533***	1.299
Decreasing interest rate	2.609**	1.135
Omitting changes in target band	3.975***	1.032

Conclusion

This paper provides an econometric analysis of the short-run impact of interest rates on the Swiss franc exchange rate covering the period January 2001 to June 2011 using daily data. This period contains 22 changes of the target 3-month CHF Libor rate band of the SNB in both directions and therefore provides quite substantial interest rate variability. Moreover, by contrast to the period from September 2011 onwards with dominant foreign exchange market interventions, the money market interest rate was SNB's major policy instrument during the 11 years considered. Our model includes both the exchange rate of the Swiss franc against euro and dollar and uses the plausible assumption that changes in Swiss interest rates have no influence on the euro-dollar exchange rate. In addition, we consider not only money market interest rate differentials, but also those for 2 and 10 years governments bonds and we take into account a couple of exogenous determinants of the exchange rates. The model is estimated by GMM assuming that there is a simultaneous relation between the Swiss interest rates and the exchange rates and that the foreign interest rates are exogenous. The simultaneity problem arises by SNB's policy reaction to exchange rate changes. This exercise indicates that a one-percentage point increase in the 3-month CHF Libor rate leads to a 3.7 % appreciation of the Swiss franc against euro and dollar. This result seems to be robust in the sense that considering only increasing or decreasing interest rates leads to no statistically significant changes of the impact estimate. The same applies for omitting approximately two weeks around target band adjustments. Our estimate appears reasonable and is between the extremely low and high estimates of the impact of Swiss interest rate changes on the exchange rate reported in the literature.

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